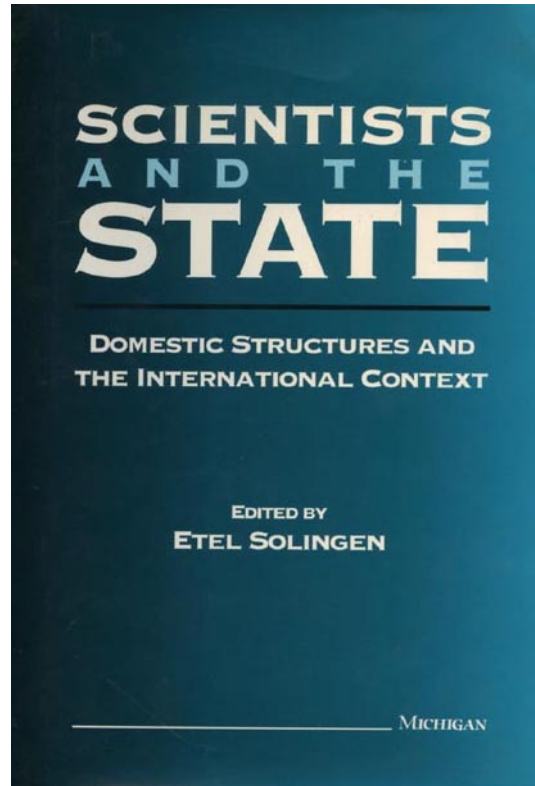


Scientists and the State: Brazil

Simon Schwartzman

Published in Etel Solingen, editor, *Scientists and the State - Domestic Structures and the International Context*, University of Michigan Press, 1994, 171-188.



Contents:

Scientists and the State	2
The "great leap forward"	5
Downhill: realities and expectations for a Ministry of Science and Technology.....	9
Possible trends	12
References:	15

Scientists and the State

In the 1970's, the Brazilian military government decided to make the country join the exclusive club of world powers, and, for a brief period, placed science and technology in a level of priority it never received before or since in the country's history. Yet, the ability governments have to obtain results on science and technology depends on previous developments they do not control. In what follows, we shall examine in some detail the assets Brazil had for this ambitious attempt, why it ultimately failed, and the consequences it left, in terms of Brazil's current scientific and technological ability to face the realities of the nineties.

Historically, Brazil has moved back and forth between stronger and weaker governments, democratic and authoritarian regimes, liberal and nationalist policies. This wavering makes it difficult to classify the country as market-oriented or centrally planned, politically competitive or authoritarian, in terms of Sonligen's typology in the introduction of this book. In very broad terms, however, there are reasons to point to a strong tendency toward political and administrative centralization and a political split between the political and administrative elites (including the military), based on the administrative centers, and the more entrepreneurial elites based in São Paulo and other Southern regions (Schwartzman, 1988). The political split between the administrative and economic elites has also led to the differentiation between two sectors in the economy, one based on private capital, often in association with foreign firms, and another based on a few large state owned companies (in oil, electricity, telecommunications, ore extraction, steel production, energy, railroads, and so forth). Besides, the Brazilian government controls a large sector of the country's financial system, through the Banco do Brasil, Caixa Econômica Federal, Banco Nacional de Desenvolvimento Científico e Tecnológico and a network of state banks. The weight of these public companies have made the Brazilian public sector the dominant one in the economy, forcing the private sector to depend on public contracts, facilities and privileges to survive. These public corporations were crucial for the country's extremely high rates of economic development up to the late 1970's, with average growth rates of about 7% a year. Yet, in the 1980's, they became burdened by increasing overhead costs, heavy indebtedness and low productivity, and the extinction, privatization and streamlining of public corporations has been an important goal of Brazil's new governments after 1990. In that sense, it is possible to say that Brazil is moving from a non-pluralistic, semi-market economy, only partially open to competition, to a pluralistic, market oriented society with a smaller state and a stronger private sector. This is the framework in which the developments described below have occurred, and are still being played.

Preconditions: from benign neglect to ritual confrontations.

Brazilian science and technology developed late, and its aspirations and predicaments seldom reached the country's higher levels of government - it is a long history of benign neglect, with a few bright spots of government awareness and scientific and technological achievements. One of these spots was the second half of the nineteenth century, when Emperor D. Pedro II, an enthusiast of modern inventions, provided for the maintenance of a few natural history museums, the astronomical observatory, botanic gardens, and attended personally to academic events in Rio de Janeiro's schools of medicine and engineering. At the

time, the country's economy was mostly centered on coffee and other plantations based on slave labor, and no thought was given to the notion that science and technology could in any way contribute to modernize it¹. Eventually, slave labor gave way to the work of immigrants, and the old Empire was replaced by a decentralized Republican regime with power in the hands of the rural oligarchies of the country's two main states, Minas Gerais and, above all, São Paulo.

Nineteenth Century Imperial science was replaced by a period dominated by applied work in agriculture and health. Endowed with large resources provided by an expanding international coffee market, the São Paulo elites created a host of teaching and research institutes at the turn of the Century, later populated by the children of immigrants from Europe, Japan and other Brazilian states who flocked to the region. Agricultural expansion brought about a few centers for applied research -- the Instituto Agrônômico de Campinas (agronomy), the Instituto Biológico, the Instituto Butantã, famous for its work on snake venom, the Bacteriological Institute, and the state's Geographical and Geological Commission. The histories of these institutions are tales of important achievements, but also of the difficulties they had in establishing long-term, good quality scientific research, their isolation from the professional schools, their reliance on foreign leadership² and the difficulties these foreigners had in carrying on their work. The most significant achievement in the period was not in São Paulo, but in the country's capital, Rio de Janeiro: it was the consolidation of the Oswaldo Cruz Institute as a first-rate center for bacteriological research and tropical disease control.

The next period, starting in the thirties, can be characterized by the search of new alternatives, and the beginnings of university-linked research. In spite of the Oswaldo Cruz Institute's achievements, Rio de Janeiro remained too narrow a basis for more comprehensive developments, and in the 1930's São Paulo would establish its permanent place as the country's most significant center for higher education and research. The achievements in São Paulo can be explained by a combination of two factors. First, the basis provided by a dynamic economy, centered on cash-producing crops (coffee above all), an emerging industrial park, hundreds of thousands of European and Japanese immigrants, several professional schools, some of them of reasonable quality, and its centers for applied research. Second, the initiative by the São Paulo elite to create, in 1934, a new university based on a School of Sciences (the Faculty of Philosophy, Sciences and Letters) staffed with foreign scholars, which inaugurated the practice of academic, university-based research in Brazil (Limoge, 1989; Schwartzman, 1991, chapter 5).

Research in high-energy physics was probably the most visible product of the new institution. A couple of Italian professors in physics and mathematics (Gleb Wataghin, Giuseppe Occhialini and Luigi Fantapíé)

¹ This is not completely true, since the old "botanical gardens" were meant as acclimatization stations for plants imported from India. Mining, however, received more attention, with less significant results. The most important initiative in this regard was the creation of the Escola de Minas de Ouro Preto in the 1870's (Carvalho, 1978).

² Among others F. W. Dafert at the Estação Agrônômica, Hermann von Ihering at the Museu Paulista, Orville A. Derby, Albert Löfgren and F. C. J. Schneider at the Geographical and Geological Commission, Adolph Lutz at the Bacteriological Institute (see, about Dafert, Dean, 1989).

with adequate knowledge of what was happening in Europe, and the active recruitment of a few bright young people, attracted by the possibilities of fellowships for studying abroad, were enough to introduce modern physics to the country, with surprising consequences for the next decades.

The post-war period, up to late fifties, is marked by the effort by scientific community to assert its role in Brazilian society, while receiving from government little more than benign neglect. In those years, the Brazilian Society for the Advancement of Science was organized in São Paulo, the first of a growing number of specialized scientific associations (Botelho, 1990; Fernandes, 1987); and, in the early fifties, the Brazilian government put in place the National Research Council, which was meant, at first, to provide support to an emerging atomic research capability (Romani, 1982; Albagli, 1987, Cagnin e Silva, 1987).

After the war atomic research was in everyone's mind, and Cesare Lattes, one among the Universidade de São Paulo's young physicists, had gained notoriety by participating in Ochiellini's work leading to the empirical determination of the meson π in 1947. The São Paulo's physicists had cooperated with the military in a few technological projects during the war, the most important being the development of sonar for submarine detection. It is not difficult to imagine how the idea of bringing these experiences together in a big atomic energy project came about. The project required an important military name, which was provided by Admiral Álvaro Alberto de Mota e Silva; a new institutional setting, this time in the country's capital; and a highly prestigious scientific figurehead, Cesare Lattes. In 1949 the Brazilian Center for Physics Research was established in Rio de Janeiro, followed two years later by the National Research Council, which included an embryonic National Commission for Atomic Research. The whole project did not go very far. The United States government did not look favorably to the project, and intervened actively when the Brazilian government tried to buy some ultra-centrifuges for uranium enrichment from Germany³. Brazil had physicists who understood about atomic theory, but knew very little of atomic energy technology. Whatever governmental support the project had, it disappeared when Brazil's president Getúlio Vargas committed suicide under pressure in 1954⁴.

After that, the National Research council lingered as a small outfit providing money for individual research projects in the natural sciences, and, with a few exceptions, nothing much except vegetative growth happened for the next ten years or so⁵. Unable to exert influence at the top, many scientists concluded that

³ In the seventies, during the Ernesto Geisel government, the U.S. would oppose again a deal between the Brazilian and the German governments in the field of atomic energy.

⁴ A less known project for nuclear fuel self-sufficiency was developed by the so-called "thorium group" at the Federal University in Minas Gerais, and came to a halt at the same time. Participants in this group became later in the formulation of the alcohol program, aiming at replacing petrol as the main source of fuel for internal combustion engines.

⁵ An important exception, however, was the establishment of a school of aeronautics engineering, the Instituto Tecnológico da Aeronáutica, in the São José dos Campos region between Rio de Janeiro and São Paulo. ITA was an exceptional institution on many accounts, from its freedom from the Ministry of Education's bureaucracy to its strong links with North American institutions, above all the Massachusetts Institute of Technology (it even had an American rector for several years). Although a military institution, its students were mostly civilian, and recruited nationwide through stringent competition. ITA became famous for its teaching standards, many of its students developed brilliant

only political mobilization from the bottom could bring them to the important roles they considered their responsibility to play. Many became enrolled in political parties on the left, and joined the student movement in campaigns for university reform. The early sixties were a time of intense political, and not always ritual, confrontation. In 1964 the military took control of the government, and started a long and intermittent process of political purges that would come to a climax in 1969, when hundreds of scientists and university professors, some of them of international prestige, lost their posts and eventually left the country.

The "great leap forward"

While, in the late sixties, conservative officers at the intelligence agencies were busy hunting for communists and suspicious intellectuals, others in Planning and Education were thinking on how not to waste the country's limited scientific talent and to build new and stronger scientific and academic institutions. The involvement of Brazil's main investment bank, government-owned Banco Nacional de Desenvolvimento Econômico, in the field of science and technology after the mid 1960's, is the most important feature of the new period⁶. For the first time in Brazil's history, there was a concerted attempt to put science and technology at the service of economic development, through the application of a substantial amount of resources. In 1964 the Bank established a program for technological development known as the Fundo Nacional de Tecnologia (National Fund for Technology), which in its first 10 years provided a total of about 100 million dollars for research and graduate training in engineering, the natural sciences and related fields⁷.

The Fundo Nacional started with the hope that economic incentives could lead private investors to develop their technologies, instead of importing them from abroad; very soon it begun to support selected teaching and research programs. This change is partially explained by the absence of coordination or shared goals between the economists belonging to the Ministry of Planning, who pushed for technological development and self-reliance, and those at the Ministry of Treasury (Fazenda), which actually decided about the country's economic policies⁸. With the Fundo's support, the Universidade de São Paulo acquired its

careers as engineers, scientists and managers. It was also at the origin of Brazil's aeronautics industry; but, curiously enough, ITA was never renowned for its scientific or technological research.

⁶ The following section is based on chapter 9 of S. Schwartzman, 1991.

⁷ Another development, not covered here, was the establishment of research departments and units within the largest state owned corporations, such as Petrobrás, Telebrás and Companhia Vale do Rio Doce. No proper evaluation of these activities were ever done, and, working within state-controlled public corporations, these research units were protected both from the academic competition typical of universities and from cost considerations derived from market pressures. The little available evidence suggests that these research institutions, although better endowed with equipment and salaries than many others, did not perform as well (Schwartzman, 1986). There was also a large and still not fully evaluated development in the field of agricultural research, which has been run by an independent agency, EMBRAPA, under the Ministry of Agriculture.

⁸ The Ministry of Industry and Trade, nominally in charge of industrial development, was never an important actor on either economics, technology or industrial policy decisions, except of a limited influence in the beginnings of the alcohol fuel program. (Schwartzman and Castro, 1984).

electrostatic accelerator, Pelletron, in 1971; a consortium of institutions started the development of a Brazilian mini-computer; the Centro Tecnológico da Aeronáutica obtained support for its development of airplane engines; the Instituto Militar de Engenharia was able to start its graduate programs in several branches of engineering and chemistry; and the newly created Universidade de Campinas received substantial grants for a variety of projects, mostly in the field of solid state physics. An important initiative was the creation of a complex system of graduate courses in engineering at the Universidade Federal do Rio de Janeiro, known by the acronym COPPE. The activities of the Fundo were later transferred to a new, specialized agency, the Financiadora de Estudos e Projetos (FINEP), working as an investment bank for technological and feasibility studies and administering a national fund for science and technology that became part of the federal budget in replacement of the development bank's fund. While some of the best known scientists expelled in the previous years remained critical of the whole undertaking, and often unable to participate, most of the young generation and the less conspicuous names joined in, without having to endorse the conservative views of the military in matters of social and political rights.

The entrance of agencies of economic development and planning into the field of science and graduate education intensified the historical tendency to favor applied technology over basic science. In 1975 the old Conselho Nacional de Pesquisas was transformed into a new and much larger Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council For Scientific and Technological Development), now under the ministry of planning. Science supporting agencies like FINEP and the Science Council evolved gradually into swollen bureaucracies of hundreds and eventually thousands of functionaries, where scientists negotiated with economists and administrators every two or three years, on a project-by-project basis, for the renewal of their grants. A two-year national plan for science and technology was promulgated in 1973, and again in 1975, projecting expenditures ranging from 323 to 824 million dollars a year (Schwartzman, 1978). These plans were little more than aggregations of expected expenses by sector, most of which -- 65% for the 1973-1975 period -- were completely outside the sphere of influence of the planning authorities, in agencies such as FINEP, the National Research Council or the Banco Nacional de Desenvolvimento. The expectation for the 1976-1977 period was to increase slightly the amount under these agencies. Between 21% and 27% of the expenditures were to be allocated to graduate training, fellowships, and "scientific development" in general; between 20% and 29% to industrial technology; between 11% and 15% to agricultural research; and between 5% and 10% to atomic energy projects. There is no known evaluation on how the plan was implemented, nor on how the expenses were made⁹.

The new emphasis on research and technology coincided with a reform of the country's higher education system that introduced several features of the American system, including full time teaching and research and graduate education. The strategy adopted by the science and technology agencies was to identify what

⁹ The third plan, for the years 1978-1979 and already under President João Batista de Figueiredo, came out in a period of economic crisis and political unification of the planning and treasury ministries under Delfim Netto, and was just a broad statement of purposes without any figures attached.

they considered good or promising research groups in universities and to provide them directly with support, very often bypassing the established procedures for labor contracts, accounting procedures and decision-making within the universities. For the researchers, there was now a "market" open for projects and proposals, and sensitive to their qualifications and aspirations. For the universities, it meant that new resources became available, but also that they flowed completely out of their control. Well equipped, well staffed and well paid departments and research programs started to exist side by side with poor ones, the first more concerned with research and graduate education, the latter bound to the traditional undergraduate schools and courses.

From the planning agencies' perspective, their strategy worked well. In 1970 there were 57 doctoral programs available in Brazilian universities; in 1985 they were more than 300, with another 800 providing training at the M.A. level (Paulinyi, 1986). About 90% of these courses were in public universities, graduating about 5,000 students at both levels each year. On all accounts, Brazil started to build a fairly significant scientific community.

The culmination of this drive was the establishment of brand new institutions, which would be free from the limitations of the past. They should be as free as possible from institutional and bureaucratic limitations or restrictions; they should be able to receive large amounts of money from science planning agencies and put them to work in the hands of well qualified people; and they should work in the frontier of the modern technologies the country supposedly needed for its economic and industrial development. Two institutions, more than others, met these requisites, the Universidade de Campinas and the engineering program of the Universidade Federal do Rio de Janeiro, COPPE. They had in common a strong, individual leadership (Alberto Luís Coimbra and Zeferino Vaz), freedom from routine bureaucratic procedures and direct support from the science and technology development agencies for their ambitious projects.

A full analysis of this experience of forceful scientific and technological development would have to include the whole field of agricultural research, some achievements in biotechnology, the development of the airplane and arms industry, the technology for steel production (Dahlman and Fonseca, 1987), and the role of institutions such as the Instituto de Pesquisas Tecnológicas in São Paulo. Two extreme cases of high technology, atomic energy and computers, stand out for their proximity with the basic sciences as well as for many other reasons, and require a closer look (Adler, 1987; Schwartzman, 1988b).

We have seen how in the mid fifties, confronted with the alternatives of trying to develop its own technology with the help of the existing scientific community or the acquisition of foreign technology, the Brazilian government chose the second. In 1975 an ambitious agreement for nuclear cooperation was signed with West Germany that implied the construction of several nuclear energy plants and the transfer of enriched uranium technology. The agreement drew strong opposition from Brazilian scientists, because it consisted mainly of the transfer of engineering technology, and did not incorporate the acquired or presumed competence of Brazilian scientists. With the oil and debt crisis starting in the late seventies, the

agreement proved to be overambitious, and it is now limited at most to the construction of two power plants, none of which is near completion as of this writing¹⁰.

A so-called "parallel program" of atomic research was also undertaken by the Brazilian military, outside the restrictions built into the German-Brazilian agreement. Rumors that Brazil is developing its own atomic bomb have never been confirmed; but the government has acknowledged the development of nuclear engines for ships and submarines, and in September, 1987, it was formally announced that Brazil had developed all the needed technology for the production of nuclear fuels for pacific purposes. The method of ultracentrifugation was said to be similar to the one used by the URENCO consortium in Europe, and the grade of enrichment, which was announced to be of 1.2%, was supposed to increase to 20% in one or two years, when an industrial plant was also supposed to start working. The work had been carried on for eight years at the Instituto de Pesquisas Nucleares from Universidade de São Paulo with support provided by the Navy, at a stated cost of 37 million dollars. The announcement was received with widespread skepticism by the Brazilian press and Brazilian scientists. The level of enrichment was considered too low for any practical purposes; the expenses too high, given the country's deep economic crisis and the other needs of scientific institutions; and the concentration of resources in military research, at the expense of civilian institutions, was seen as a worrisome trend.

While a key feature of the nuclear program was the exclusion of university-based scientists and the development of large, state-controlled bureaucracies, the computer industry started from people coming out of the universities, and gave rise to several privately owned companies, which grew under the umbrella of market reserve (Adler, 1987; Schwartzman, 1988c; Frischtak, 1986). This policy coincided with the worldwide explosion of the microcomputer industry. By the end of 1984, at the closing of the military regime, a bill defining a "national policy for informatics" was approved by the Brazilian Congress by a majority of votes from government and the opposition parties.

There were many remarkable elements in this policy, which generated many studies, international press coverage and threats of retaliation from the Reagan government. The main novelty was that this was the first attempt in Brazil's history to develop an industrial policy based on local technology and purely Brazilian firms. The Brazilian policy for computers is an extreme case of "backward integration," in which production starts with the assembly of the final product with imported parts, with the expectation that the product would incorporate an increasing amount of locally produced components (Nau, 1986). Such a policy would require, among other things, a corresponding investment in research and development, which in the Brazilian case did not exist. The weakness of the research effort is one reason why the Brazilian policy for the computer industry came under severe criticism not only from foreign competitors hoping to sell in the Brazilian markets, but also from end-users and manufacturers in the country who see this policy

¹⁰ There is only one working atomic energy plant in Brazil, built by Westinghouse in Angra dos Reis before the German agreement, known for its successive technical difficulties and overrun costs. Large investments have been made on a sister plant, which has remained inconcluded.

as a growing roadblock to their access to state-of-the art technologies. The market protection policy for microcomputer was officially abandoned by the Brazilian government in 1992. In computers, as in atomic energy and in other applied fields, the great leap forward was far shorter than the original expectations.

Downhill: realities and expectations for a Ministry of Science and Technology.

Brazil was unfortunate in that political freedom and democratic rule started to be implemented precisely when economic crisis stuck, in the 1980s¹¹. The Ministry of Science and Technology was established by the new civilian regime in 1985, in response to demands from a significant section of Brazil's scientific community. The Brazilian Society for the Advancement of Science, SBPC, produced at the time a document outlining the critical issues in the country's scientific institutions and the hopes for the new era (Comissão das Sociedades Científicas, 1985). The expectation was that the new agency could at least maintain and strengthen the country's scientific and technological research institutions, so that they could not be destroyed or maimed, as it happened so often in the past, by indiscriminate measures of budgetary restraint, inconsiderate bureaucratic decisions or sheer political patronage. This role of protecting the country's scientific assets was to be accompanied by new institutional mechanisms to strengthen the research institutions, stimulate academic and scientific exchange and cooperation, and turn basic research into an effective instrument of social and economic development. The Ministry of Science and Technology was supposed to articulate a long-range policy for scientific and technological development, with the scientific community's help and to be approved by a freely elected Congress. Finally, there was the expectation that the new ministry could help in the definition of a "new and well defined industrial policy, with economic incentives to companies willing to develop national technologies and financing instruments adjusted to the risks involved," as a way of overcoming the country's economic and technological dependency from outside.

The common understanding was that, to carry out these tasks, the new ministry would need to be closely watched and helped by the country's scientific community. In fact, interactions between scientists and government underwent significant transformations since 1985. Peer review has been a tradition at the National Research and CAPES, at the Ministry of Education, for a long time. Before 1985, however, participation of scientists in collegiate bodies was always by invitation, or co-optation. After 1985 these two agencies developed elaborate systems for nomination of advisers and reviewers by scientific associations and research groups, and the very presidency of the National Research Council was given to a former president of the Brazilian Association for the Advancement of Science. A new interministerial body for science and technology coordination, the Council of Science and Technology (CCT) was also instituted, with the presence of government ministers and representatives of the scientific community.

¹¹ It was probably not just a coincidence; the gradual steps taken by the Figueiredo regime (1978-1985) to return the country to civilian rule have been interpreted as a kind of deliberate decision by the military for strategic withdrawal in face of the failure of the grandiose development plans of the previous years.

This trend of increasing representation of scientists on decision-making bodies came under difficulties and criticism on different and sometimes conflicting grounds. The swollen bureaucracies in the agencies resented the scientists' interference with their decision powers, and tried to develop alternative mechanisms for their action; well established scientists questioned the impartiality of reviewers selected through institutional and regional affiliation, rather than strict academic criteria; new, emerging and less qualified groups were afraid that reviewers from the more developed regions and institutions would concentrate resources on their hands; economists and civil servants complained about the dispersal of resources, and called for more planning and the establishment of priorities; while traditional politicians pressed for personal and partisan criteria in the distribution of benefits such as fellowships and research grants.

The net result was that, in the new and expanded political arena of the post-military regime, the scientists had to fight for access and control of science policies, agencies and resources with much more and unexpected partners than they imagined. Budgetary data for 1987 show that the Ministry of Science and Technology controlled only about 30% of federal expenditures defined as R&D; another 20% belonged to the Ministry of Agriculture, 14% at the Ministry of Education (mostly for graduate education) and 16.5% remained directly under the President. Seen from another perspective, 60% of the resources in that year were linked to about 20 large projects or programs. Of this 60%, 36.6% were attributed to military projects, 18.7% to agricultural research, and less than 30% to the National Research Council and the National Fund for Scientific and Technological Development (table 1). No coordination existed among these different ministries and projects, and the inter-ministerial council responsible for establishing a global policy and budget never acted in that capacity. Besides the scattering of R&D resources throughout the Federal Government, science policy decisions within the realm of the new Ministry became subject to a variety of other influences besides that of the scientists -- bureaucrats, regional interests, teachers' and employees' associations and unions, politicians, lobbyists for technologically intensive industries, and so forth. As soon as it was established, the new Ministry started to build a complex bureaucracy for science and technology planning in all areas of the so-called "new technologies," with no provision for regular peer review evaluations except by occasional invitation.

Four years later, at the end of José Sarney's presidential period, few of the expectations surrounding the new ministry of S&T had been fulfilled, and the problems affecting the country's scientific and technological institutions were much worse than before¹². It is true that political restrictions to scientists and their work had ceased to exist. There was also, at the beginning, a substantial expansion of resources for the National Research Council, (mostly through an increase in the number of fellowships available for researchers and graduate students), significant increases in the salary levels of university professors and researchers in the Federal system, and an ambitious program of fellowships for graduate education abroad was announced.

¹² The following is based on Schwartzman and Reis, 1989.

Seen from hindsight, it is clear that the resource expansion in those years did not follow a well defined governmental commitment with science and technology, but was just another item in a general pattern of uncoordinated expenditure expansion, one cause of uncontrolled inflation in the succeeding years. The rapid expansion of the number of fellowships for studies abroad, to give an example, was not accompanied of any measure to create new working opportunities for returning graduates, generating a potential for increasing brain drain. In another example, although the government kept the letter of the legislation defining a national policy for the computer industry based on market protection and scientific development in the field, no industrial policy was devised to follow this legislation, nor was any priority given to research and development activities in the field.

The Ministry of Science and Technology was never perceived by the federal government as an agency to carry on specific policies, but just as a concession to be given to a specific sector of the PMDB party that provided it with political support. For the government, scientists and technologists were just another lobby pressing for their private interests, to be contemplated according to their political clout. For a while, within its narrow limits, the new Ministry and their holders could do more or less as they wished, and benefit simultaneously from the expansion of public expenditures. They lacked influence, however, on several of the most significant sectors of technological research, such as agriculture, nuclear, space, and on the industrial and educational policies. As the economic crisis increased, and the political alliances supporting José Sarney eroded, that the Ministry could not protect the scientific institutions from budget slicing, barriers to the acquisition of instruments and materials abroad and restrictions to international travel for scientists. More seriously, it became obvious that the new Ministry was not immune to the practices of pork-barrel politics prevailing in other sectors of the federal administration.

The picture became clear when, at some point in 1988, the political alliance between the Sarney government and the more militant sector of the PMDB party broke down, leading to the nomination of a new Minister of S&T with little or no links with the more active sectors of the scientific community. One of the first acts of the new Minister was to issue a decree withdrawing all decision powers of the academic council (Conselho Deliberativo) of the National Research Council, which led to an intense mobilization of scientists, and a retreat from the government on that measure. From that point on the behavior of the Sarney government regarding the area became extraordinarily erratic. First, the Minister agreed to go back in his decree, and to open a discussion with the scientific community on the reorganization of the Research Council; then the Ministry itself disappeared, absorbed by the old Ministry of Industry and Trade, to be later reestablished as a "special secretary" for science and technology under the President; and finally, in December, 1989, it was reinstated again as a full-fledged Ministry. The administrative reform introduced in early 1990 by President Fernando Collor reinstated the Secretary of Science and Technology roughly with the same attributions, and never granted it a significant role.

Possible trends

The crisis that affects the scientific community in Brazil in the early 1990's is likely to be deeper than the simple consequences of an incompetent government and runaway inflation. There are signs suggesting that the pattern of scientific development started in the late sixties (and agonizing since the early eighties) is approaching its end, without any clear indication of what will replace it, or even whether it will be replaced at all.

A first sign in this direction was the drastic reduction of the federal budget for science and technology since 1989, coming almost to zero (except for fellowships and money from a World Bank loan) in 1991-2. There was some expectation that this withdrawal of the federal government from science and technology could be partially compensated by the creation of several budgetary funds and foundations for science and technology in many Brazilian states. In the past, only São Paulo had its science foundation, the Fundação de Amparo à Pesquisa de São Paulo, whose budget increased from 1/2 to 1% of state-level taxes in 1990¹³. State constitutions approved throughout the country in 1989 provide fixed allocations going up to 3% of state budgets or taxes in many other states. In some places, like Minas Gerais, Rio de Janeiro and Rio Grande do Sul, science foundations similar to FAPESP were organized; in others, the money remained at the discretion of the state governor or some political appointee. Few states will be able to reproduce the institutional and ethical conditions that made FAPESP a highly effective and praised institution, strong enough to withstand the opposition or indifference of a populist governor. Even in the best scenario, the new money being provided for research at the state level will not compensate for the shrinkage of federal resources, and inter-regional inequalities in R&D allocations will tend to increase (this pattern of reduction of federal expenditures without compensatory allocations at the state and local levels is a general feature of the Brazilian 1988 Constitution, rather than something specific of the science and technology field).

A second sign is the loss of legitimacy of academic research and higher education as worthy recipients of federal funds, in the name of applied R&D and basic education. The designation of José Goldemberg, the former rector of the Universidade de São Paulo and a well known physicist, to the Secretary of Science and Technology (and later Ministry of Education), by the Fernando Collor government, was a gesture signaling the new government's commitment with the strengthening and improvement of the science and technology sector. In practice, the money available for scientific and technological research continued to shrink, and successive statements about the need to give more emphasis on applied work were not followed by specific policies.

¹³ . FAPESP's budget for 1991 was about US\$ 114 million, 82% of which going to direct support for research projects, and 9% for fellowships.

From the beginning, short-term economic and administrative issues, followed by crisis of legitimacy, monopolized the new government's attention, and there are no definitions about the mechanisms, speed and investments that could shape new policies for the years to come¹⁴.

The Brazilian economy is going through a deep readjustment, likely to last for several years, that will keep public expenditures down, and open the economy still further for foreign investments and capital. This trend does not bode well for industrial policies based on market protection and technological self-sufficiency, as existed for the computer industry; and there are no signs that the country is ready to develop technology-intensive industries able to survive in a world of increasing competition, with or without government incentives. Public higher education, which has been stagnant since the early eighties, is likely to remain so in the future. One consequence has been the reduction of the labor market for graduate degree holders, with negative implications, in terms of demoralization and lack of stimulus, for the research graduate programs at the universities.

If this scenario is correct, the scientific community is likely to react through increasing mobilization and confrontation against the federal government. The ultimate fate of this confrontation will depend on whether the government will succeed in its economic adjustment measures. If it fails, the opposition it will get from the scientific community will not be different from the opposition it will get from a wide range of organized sectors in Brazilian society, from trade-unions to public employees, teachers' associations and the press. Even if it succeeds, nothing will be like before. Brazilian scientists will have to live in a much tighter reality, where their projects will have to be justified for their economic, social and educational worth, in face of stiff international competition. This will be a wholly new experience, for which neither the Brazilian government nor the scientists are prepared to face.

Project	Value in Cz\$ 1.000	percentage among the large projects	% of total S&T projects
Advanced research projects related to National Security, National Security Council	1.000.000	10,1	5,8%
Space and satellite development program, Armed Forces High Command	1.283.800	13,0%	7,5%
Applied and basic research, National Commission of Atomic Energy	398.600	4,0%	2,3%
Aerospace research and	476.500	4,8%	2,8%

¹⁴ In March, 1992, the new Secretary for Science and Technology, sociologist Hélio Jaguaribe, announced that the government would give two thirds of its research money to applied work, and one third to basic sciences. Past history shows that this preference for applied work has been the pattern all along; the problem is the ability of the productive sector to absorb and benefit from these incentives, if they materialize.

development, Ministry of Aeronautics			
Sectoral Program on Ocean Resources, Ministry of Navy	115.000	1,1%	0,7%
Antarctic Mission, Ministry of Navy	260.000	2,6%	1,5
Submarine project, Ministry of Navy	103.800	1,0%	0,6%
Applied research in Agriculture, EMBRAPA, Ministry of Agriculture	1.637.125	16,5%	9,6%
Graduate education fellowships program, CAPES, Ministry of Education	576.882	5,8%	3,4%
Development of agricultural technology for the improvement of sugar cane crops, Ministry of Agriculture	126.203	1,2%	0,7%
Research on natural resources, Superintendence for the Development of the Amazon Region, Ministry of Interior.	100.000	1,0%	0,6%
Research and experimental development, Oswaldo Cruz Institute, Ministry of Health	245.262	2,5%	1,4%
Studies and research for transports planning, Brazilian Company for Transports Planning, Ministry of Transports	114.600	1,1%	0,7%
Basic research, National Research Council, Ministry of Science and Technology	333.340	3,4%	1,9%
Applied research, National Research Council, Ministry of Science and Technology	200.000	2,0%	1,2%
Current expenditures of seven research institutes and national laboratories of the National Research Council	335.599	3,4%	2,0%
Graduate education fellowships, National Research Council	442.080	4,5%	2,6%
research fellowships, National Research Council	382.000	3,9%	2,2%
Program of Energy Mobilization,	663,905	6,7%	3,9%

General Expenditures of the Federal Government			
National Fund for Scientific and Technological Development, Ministry of Science and Technology (FINEP)	1.114.122	11,2%	6,5%
Total	9.909.033	100%	58,8%
other expenditures	7.176.967	-----	41,2%
grand total	17.086.000	-----	100%
Source: Ciência e Tecnologia, Orçamento da União 1987, MCT/CNPq. The figure for FINEP, part of the overall budget of the Ministry of Science and Technology, was obtained directly by FINEP.			

References:

Adler, Emanuel, 1987: *The Power of Ideology - The Quest for Technological Autonomy in Argentina and Brazil*, Berkeley, University of California Press.

Albagli, S., 1987: "Marcos Institucionais do Conselho Nacional de Pesquisas", *Perspicillum*(Rio de Janeiro, Museu de Astronomia e Ciências Afins), 1 (May): 1-166.

Botelho, Antonio Jose Junqueira ,1990: "The Professionalization of Brazilian Scientists, the Brazilian Society for the Progress of Science (SBPC), and the State, 1948-60". *Social Studies of Science* 20, 473-502.

Cagnin, M. A. H. e Silva, D. H (1967): *A Ação de Fomento na História do CNPq*, Brasília, Ministério da Ciência e Tecnologia / CNPq, 1987.

Carvalho, José Murilo, 1978: *A Escola de Minas de Ouro Preto - O Peso da Glória*, Rio de Janeiro, Editora Nacional/ FINEP.

Chacel, J, Pamela S. Falk and David V. Fleischer, 1988: *Brazil's Economic and Political Future*. Boulder, Colorado: Westview Press.

Comissão das Sociedades Científicas, 1985: *Ciência e Tecnologia na Nova República: Relatório Apresentado ao Ministério de Ciência e Tecnologia pelas Sociedades Científicas*, November, mimeographed.

Dahlman, Carl J. and Fonseca, Fernando Valadares, 1987: "From Technological Dependency to Technological Development: the Case of Usiminas Steelplant in Brazil", in Katz, 1987.

Dean, Warren, 1989: "The Green Wave of Coffee: Beginnings of Tropical Agricultural Research in Brazil" (1885-1900), *Hispanic American Historical Review* 69, 1:91-116.

- Fernandes, Ana Maria, 1987: *The Role of the Brazilian Society for the Advancement of Science, 1948-1980*. Doctoral Dissertation, St. Antony's College, Oxford university, 385 pp.
- Frischtak, C., 1986: "Brazil", in Rushing and Brown, 1986, 31-70.
- Katz, Jorge (ed), 1987: *Technology Generation in Latin America Manufacturing Industries*, New York, St. Martin's Press.
- Limogi, Fernando, 1989: "Mentores e Clientelas da Universidade de São Paulo", in Miceli, 111-187,
- Miceli, S. (ed), 1989: *História das Ciências Sociais no Brasil*, vol. 1. São Paulo, Edições Vértice.
- Nau, Henry, 1966: "National Policies for High Technology Development and Trade: An International Comparative Assessment", in Rushing and Brown, 1986, Chapter 2.
- Paulinyi, E. and others, 1986 - *Indicadores básicos de ciência e tecnologia*, Brasília, Conselho Nacional de Desenvolvimento Científico e Tecnológico, mimeographed
- Romani, J. Pitangui, 1982: "O Conselho Nacional de Pesquisas e a institucionalização da pesquisa científica no Brasil", in Schwartzman 1982: 137-68.
- Rushing, Francis W. and Carole G. Brown, *National Policies for High Technology Industries-International Comparisons*. Boulder, Colorado: Westview Special Studies in Science, Technology and Public Policy.
- Schwartzman, S., 1978: "Struggling to be Born: The Scientific Community in Brazil", *Minerva*(London) 16, 4, p. 545-80.
- Schwartzman, S. (ed), 1982: *Universidades e Instituições Científicas no Rio de Janeiro*, Brasília, Conselho Nacional de Desenvolvimento Científico e Tecnológico.
- Schwartzman, S., 1986: "Coming Full-Circle: for a Reappraisal of University Research in Latin America." *Minerva* (London), 34, 4 (Winter), 456-476, 1986.
- Schwartzman, S., 1988: *Bases do Autoritarismo Brasileiro*, Rio de Janeiro, Ed. Campus, 3rd edition.
- Schwartzman, S., 1988b: "The Power of Technology" (review essay), *Latin American Research Review*, 24, 1.
- Schwartzman, S., 1988c: "High Technology vs. Self-Reliance: Brazil enters the Computer Age", in Chacel, Pamela and Fleischer, 1988, 67-82
- Schwartzman, S., 1991: *A Space for Science - The Development of the Scientific Community in Brazil*, University Park: The Pennsylvania State University Press,
- Schwartzman, S. and Maria Helena M. Castro, 1984: "Nacionalismo, Iniciativa Privada e o Papel da Pesquisa Tecnológica no Desenvolvimento Industrial: Os Primórdios de um Debate" *Dados - Revista de Ciências Sociais*, Rio de Janeiro, IUPERJ), 27,1, 89-111.

Schwartzman, S. and Fábio W. Reis, 1989: "Ciência e Tecnologia na Nova República" (document prepared for the Commission of Scientific Societies), *Ciência Hoje* 9, 50 Feb, 62-69.
